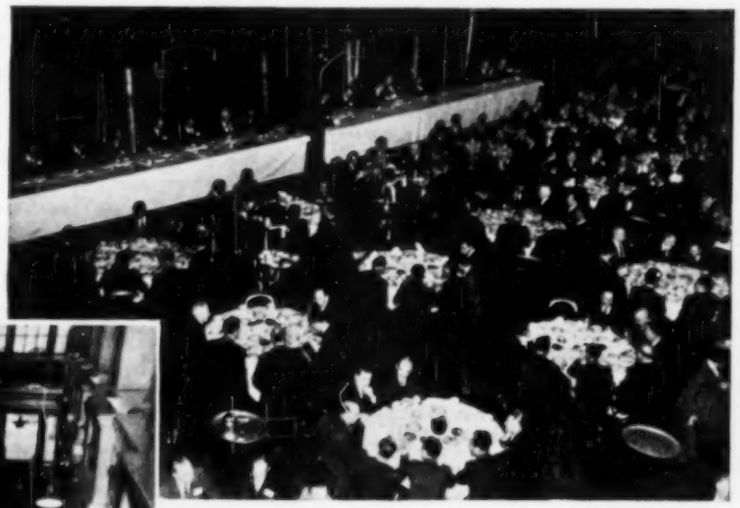
Industrial QUALITY CONTROL

VOL. II MARCH, 1946 NO. 5

THE ROCHESTER CLINIC

AT RIGHT—
The Luncheon Meeting



ABOVE—
Gage and tool exhibits

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AMERICAN SOCIETY FOR QUALITY CONTROL

INDUSTRIAL QUALITY CONTROL
Published Bi-monthly
by the
AMERICAN SOCIETY FOR QUALITY CONTROL

George D. Edwards, President;
Bell Telephone Laboratories
New York, N. Y.

Andrew I. Peterson, Vice President;
Radio Corporation of America
Victor Division, Harrison, N. J.

Ralph E. Wareham, Executive Secretary;
National Photocolor Corporation
New York, N. Y.

Alfred L. Davis, Treasurer;
Rochester Institute of Technology
Rochester, N. Y.

INDUSTRIAL QUALITY CONTROL is published in January, March, May, July, September, and November, and is mailed to all members of the Society as one of the privileges of membership.

* * *

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AMERICAN SOCIETY FOR QUALITY CONTROL

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General Information

Membership in the Society is available through local affiliated societies or directly through the Executive Secretary. Annual dues are five dollars for direct national membership. Information concerning local societies should be obtained from local secretaries.

Founding Memberships in the Society are available prior to July 1, 1947 by an additional payment of five dollars or more.

Correspondence concerning membership and allied matters should be addressed to,

Ralph E. Wareham,
305 E. 43rd St.
New York 17, N. Y.

Correspondence concerning financial matters should be addressed to,

Alfred L. Davis, Treasurer
Rochester Intsitute of Technology
Rochester 8, N. Y.

Editorial correspondence and requests for back issues should be adressed to,

Martin A. Brumbaugh
University of Buffalo, Crosby Hall
Buffalo 14, N. Y.

INDUSTRIAL QUALITY CONTROL
was founded in 1944 by the
SOCIETY OF
QUALITY CONTROL ENGINEERS
BUFFALO
in cooperation with
THE UNIVERSITY OF BUFFALO

Editorial Board

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COST OF BACK ISSUES

Volume I of INDUSTRIAL QUALITY CONTROL, which includes the July, 1944, September, 1944, November, 1944, January, 1945, March, 1945, and May, 1945 issues, is available at a price of $5.00. Individual copies of Volume I and the July, 1945, September, 1945, November, 1945, and January, 1946, issues of Volume II are available at a price of $1.00 each.

The Special Management Issue, published in January, 1946, has had such wide distribution that a large printing is becoming exhausted. While they last, copies may be obtained either singly or in bulk at a cost of $.25 per copy.

Midwest Quality Control Conference

If the program of the Midwest Quality Control Conference printed in the January issue of INDUSTRIAL QUALITY CONTROL appeared to be slightly ambitious, it can now be reported that the advance expectation was completely realized. Seven hundred persons registered for the Conference and 200 to 300 persons could not be accepted because of space limitations.

The general sessions held the first day provided overall background and served to introduce many new ideas to the group. This general program was carefully planned to provide information for the beginner, guidance for the established operator, and a sound point of view for all.

The clinics which were in continuous session from 9:00 a.m. to 5:00 p.m. during the second day held the attention of all. Perhaps the most noteworthy single feature of the clinics is the fact that the series of four clinics for neophytes, conducted by Professor Lloyd Knowler, were filled to capacity. This indicates the spread of interest in quality control and shows that new entrants into the field prefer to have a sound basic knowledge of control technique.

As the Conference progressed, those in attendance expressed increasing interest in securing a record of the proceedings. Several possible methods of accomplishing this were discussed by the Conference Managers. Final plans are in the making as this magazine goes to press. There is considerable possibility that the entire report of the Conference will be published in INDUSTRIAL QUALITY CONTROL.

About one-half of the available space of each of the next four or five issues would be devoted to these reports. In this way all members of the American Society for Quality Control would be able to obtain first hand knowledge of what occurred at the Conference. Those who attended the Conference would perhaps prefer a somewhat more prompt reporting. At the same time serial publication spreads somewhat the impact of the reports on the reader, and for that reason may encourage more thorough rather than less thorough perusal.

AMERICAN SOCIETY FOR QUALITY CONTROL

PREFACE

When the history of the beginnings of Quality Control development in this country is written, February 16, 1946 will be an important date. On that date representatives of seventeen local quality control societies and leaders in the field met at the Edison Electric Institute in New York City for the announced purpose of launching the American Society for Quality Control. This action is the final consummation of nearly two years of effort on the part of quality control leaders. During these two years a host of organizational difficulties have been surmounted and hours of unglamorous spade work have been done by so many people that it would be futile to attempt to catalog individual contributions.

The American Society for Quality Control belongs to the men and women in the United States and Canada who are practicing and promoting the industrial science of better quality through control. Anyone even remotely connected with an industrial control project is well aware of the virtually unlimited opportunity for product and process improvement, and the cost reduction possibilities bound up in the application of control technique. Your Society is wholly devoted to the advancement of the interests of its members through the expansion of the use of control technique and through more precise evaluation of their contribution to industrial progress. The purpose of the Society is more completely stated in the Constitution which is reproduced on a succeeding page of this issue.

MINUTES FEBRUARY 16 MEETING

Date: February 16, 1946

Place: Edison Electric Institute, New York City, New York

The meeting was called to order at 9:30 a. m. by Mr. Joseph Manuele with authorized representatives of seventeen local societies and about twenty leaders in the field in attendance. Mr. Manuele outlined his function in bringing all groups together for the meeting. He then stated briefly, but pertinently, the steps in previous organizational efforts which had led to this meeting.

Mr. Manuele appointed Mr. Ralph Wareham Secretary pro tem, and the meeting then proceeded to official certification of the number of votes which each society was entitled to cast in the meeting. (All voting was based on paid local society membership as of December 31, 1945).

Mr. Manuele then called for the election of a chairman of the meeting.

Mr. Martin Brumbaugh was elected and took the chair immediately.

Mr. Frederick Halton presented the proposed Constitution which had been circulated previously to all concerned. Mr. Halton explained the features of the document and asked for several changes in wording to be inserted in the mimeographed text. He then answered a number of questions from the floor and a general discussion ensued. He then moved the adoption of the Constitution. After the motion was seconded, two amendments were offered: (1) A motion to increase the annual dues forwarded by local societies to the American Society from $3 to $5 (motion lost;) (2) A motion to change the method of amending the Constitution so that amendment by mail ballot could be used to effect necessary changes between annual meetings (motion adopted unanimously.) The vote to adopt the Constitution as amended was unanimously affirmative.

A motion was passed authorizing the Executive Secretary to make minor changes in the text of the Constitution as adopted to correct punctuation, misspelling, bad word order, poor choice of words, etc., so long as no change of intent is involved.

Mr. Brumbaugh then called for the election of officers as provided in the Constitution, and the following officers were elected:

President
Mr. George D. Edwards
Director of Quality Assurance
Bell Telephone Laboratories

Vice President
Mr. Andrew I. Peterson
Manager of Quality Control
Radio Corporation of America
Victor Division

Executive Secretary
Mr. Ralph E. Wareham
Manager New Products Division
National Photocolor Corporation

Treasurer
Mr. Alfred L. Davis
Rochester Institute of Technology

Mr. Edwards took up his duties as President by assuming the chair at this point, and in a brief extemporaneous speech outlined some policies for the Society.

He stated that, while this was not a case of the man seeking the office, he felt greatly honored by the choice of the delegates and would make every effort to justify the confidence expressed by the selection. He pointed out the difficulties involved in securing united action by scattered groups, and expressed the belief that the present meeting had achieved unanimity of purpose and had delivered a clear mandate which he accepted with a most humble sense of the deep responsibility which such acceptance entails.

He added that the Constitution makes the Board of Directors and the Executive Committee responsible for operating decisions and policy making. The President is merely the presiding officer and is responsible along with the other officers for carrying out the decisions of the Board and the Committee. Briefly, the Constitution and By-Laws clearly indicate that the framers intended to have the representatives of the local societies run the national organization in policy and action.

He stated his intention of implementing this plan of the framers and bespoke for himself and his fellow officers the support of local officers and the rank and file of the society in providing a strong Board of Directors.

He stressed the importance of clearcut action in the months immediately ahead but stated his belief that with National Officers, National Board, Local Officers and Individual Members unified in purpose and in method the task of getting the new Society underway will be accomplished. He spoke for all of the National Executives in accepting the actions of the meeting as a command to go forward.

A motion was made and adopted unanimously directing the Executive Secretary to prepare and send a letter of appreciation from the American Society for Quality Control to Messrs, Martin A. Brumbaugh, Frederick J. Halton, Joseph Manuele, Andrew I. Peterson, Edward M. Schrock, Walter A. Shewhart, and Ralph E. Wareham, for their constructive contribution in bringing about the new Society.

A resolution was unanimously adopted to express the appreciation of the American Society for Quality Control to the Edison Electric Institute for the use of its Board Room.

The meeting adjourned at 12:30, with an afternoon session called for 2:00.

AFTERNOON SESSION

The Federated Societies (Buffalo, Michigan, Rochester, and Syracuse) announced that at a meeting held during the lunch recess the Board of Directors of the Federation had voted to merge all of its activities with the American Society for Quality Control and to terminate the existence of the Federation.

A resolution was adopted by the American Society for Quality Control approving the merger of the Federated Societies into the American Society for Quality Control.

The meeting of the American Society for Quality Control adjourned temporarily while Mr. Schrock, President of the Society for Quality Control, conducted a meeting of the Board of Directors of that Society. The authorized representatives of twelve local member societies voted unanimously to merge the Society for Quality Control, including the assets and liabilities of the organization, with the American Society for Quality Control.

After the meeting of the American Society for Quality Control reconvened, a resolution was adopted by the American Society for Quality Control approving the merger of the Society for Quality Control into the American Society for Quality Control and accepting all of the assets and liabilities of the Society for Quality Control.

Mr. Alfred J. Winterhalter presented a statement of the financial operations of INDUSTRIAL QUALITY CONTROL since its founding in July, 1944, and reported that the Society of Quality Control Engineers and the Federated Societies had voted to offer the magazine, including all of its assets, liabilities, and unfulfilled subscription obligations, to the American Society for Quality Control.

The financial statement appears as Exhibit A.

The vote to take over INDUSTRIAL QUALITY CONTROL was unanimous. It will henceforth be a publication of the Society.

A motion was made and passed to authorize the President to proceed with the incorporation of the American Society for Quality Control, with the officers as incorporators, if possible, or with the officers and directors as incorporators, if necessary.

Exhibit A

Balance Sheet of INDUSTRIAL QUALITY CONTROL

as of February 13, 1946

Assets		
Bank balance		
Receipts	2464.69	
Payments	2409.39	
Net		$ 55.30
Cash on hand		47.25
Postage on hand		19.30
Stationery on hand		20.00
Sales value of back issues		600.00
Sales value of special issue		175.00
Accounts receivable		
Sales of special issue	212.50	
Advertising	76.50	
Subscriptions billed	60.00	
		349.00
		$1265.85
Liabilities		
Society of Quality Control Engineers	496.75	
Unfulfilled subscription obligations	750.00	
		1246.75
Net Worth		$ 19.10

Motion adopted to place the operation of the magazine in the control of the Editorial Board provided for this purpose in the Constitution.

President Edwards announced the members of the Editorial Board: Martin A. Brumbaugh, Chairman, Cecil C. Craig, A. E. R. Westman, William B. Rice, Lloyd A. Knowler, Harold F. Dodge, Paul Peach, Irving W. Burr, Ellis R. Ott, Joseph M. Juran, Leslie E. Simon, Frederick Mosteller. The membership of this Board was approved.

The personnel of other committees has not been completed, hence announcement of these names will be reserved until the May issue of INDUSTRIAL QUALITY CONTROL.

The Lincoln Rochester Trust Company of Rochester, New York, was approved as a depository for funds of the Society.

The Executive Committee of the Board of Directors is not complete. Regional members selected thus far are:

New England Region—C. J. Hudson

Northern Region—Alfred J. Winterhalter

Middle Atlantic Region—Paul S. Olmstead

Central and Southern Region — Midwest Region—Frederick J. Halton

Western Region—

The boundaries of the six regions are as follows:

Region I: New England States
Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut (except western part).

Region II: Northern
New York (except metropolitan New York area), Northern Pennsylvania, Lower Michigan (and Toledo, Ohio), and adjacent Canada.

Region III: Middle Atlantic States
Metropolitan New York area, Western Connecticut, New Jersey, Eastern Pennsylvania, Delaware, Eastern Maryland, District of Columbia, and Foreign.

Region IV: Central
Ohio (except Toledo), Western Pennsylvania, Western Maryland, Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi.

Region V: Western
Indiana, Illinois, Upper Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Nebraska, Iowa, Missouri, Kansas, Arkansas, Oklahoma, Louisiana, Texas.

Region VI: Western
Montana, Wyoming, Colorado, New Mexico, Idaho, Utah, Arizona, Nevada, California, Oregon, Washington.

CONSTITUTION and BY-LAWS
AMERICAN SOCIETY for QUALITY CONTROL

Article I — Name

Section 1

The name of this Society shall be:

AMERICAN SOCIETY FOR QUALITY CONTROL

and shall hereafter be referred to as the "Society." This Society is organized as a non-profit organization.

Article II — Purpose

Section 1

The purpose of this Society shall be the advancement of and diffusion of knowledge of the science of Quality Control and its applications to industrial progress; to these ends it is part of the purpose of this Society to sponsor the publication of a journal and to foster such other publications as desirable, devoted wholly or mainly to Quality Control, to serve the public by making available to journals, newspapers and other channels of public information, reliable communications concerning Quality Control and its progress; to pool with local, national and international organizations and technical societies all matters of common interest; to promote unity and effectiveness of effort among all those who are devoting themselves to Quality Control of industrial processes, by research, by application of its principles, by teaching or studying.

Section 2

Local societies may retain their name, identity and autonomous powers provided they are not in conflict with the Constitution and By-Laws of this Society.

Article III — Membership and Dues

Section 1

Membership in this Society shall be open to anyone who is actively engaged in or interested in Quality Control.

Section 2

Each local society shall remit annually the sum of three dollars for each member of the Society which shall include a subscription to the journal and membership in the Society.

Section 3

Any eligible person desiring membership in the Society, who is not a member of one of the local societies, may become a member of the Society upon payment of annual dues of five dollars to the Society, which membership shall include a subscription to the journal.

Section 4

A member shall be in good standing and eligible to vote, whose dues are not in default six months past the end of the fiscal year.

Section 5

The fiscal year shall extend from July 1 to June 30.

Section 6

Any member may become a Founding Member by paying an additional sum of not less than five dollars before June 30, 1947.

Section 7

Contributions will be accepted from corporations and companies but will not be solicited.

Article IV — Officers, Board, Council and Committees

Section 1

The officers of the Society shall be President, Vice President, Executive Secretary, and Treasurer.

Section 2

The Board of Directors shall consist of the above four officers, the Chairman of the Editorial Board and the authorized representative from each local society. Hereafter the Board of Directors shall be referred to as the "Board" and the authorized local representative as the "Director."

Section 3

All officers, members of committees, and candidates for office, shall be members in good standing.

Section 4

The President, or in his absence the Vice President, or in the absence of President and Vice President, a member selected by vote of the members present, shall preside at regular meetings of the Society and at all meetings of the Board of Directors and the Executive Committee. In the event of the death or resignation of the President, the Vice President shall become President. At meetings of the Society, the presiding officer shall vote only in the case of a tie, but at meetings of the Board of Directors he may vote in all cases. Subject to the approval of the Board, the President shall fill all vacancies occurring among the officers, appoint the Chairman and other members of the Editorial Board and all committees, and from time to time may make such changes in committee personnel and size as he deems wise.

Section 5

The Board shall have general management and supervision of the affairs of the Society.

Section 6

No officer, director, member of a committee or council shall be paid for services.

Section 7

The Executive Secretary shall keep a full and accurate record of the proceedings of the meetings of the Society and of the Board of Directors and of the Executive Committee; send out calls for said meetings and carry on correspondence of the Society, except as otherwise herein provided. Subject to the direction of the Board, he shall have charge of the archives of the Society. At suitable intervals the Executive Secretary shall publish the Constitution and By-Laws and a membership roll, both of which shall be supplied to each member.

Section 8

The Treasurer, who shall be bonded in an amount to be fixed by the Board, shall collect and receive all funds due and belonging to the Society; shall have custody of all funds and securities thereof, shall deposit the same to the credit of the Society in such depository as the Board shall direct, and shall disburse the same in the manner authorized and directed by the Board. The Treasurer shall make a detailed financial report to the Board within thirty days after the end of each fiscal year. The Treasurer's report shall be audited by the Auditing Committee appointed by the Board. The Auditing Committee shall make a report to be published with the Treasurer's report.

Section 9

There shall be an Editorial Board consisting of a Chairman and such members as the Board of Directors may approve. The Chairman of the Editorial Board, with the approval of the Editorial Board, shall be responsible for the form and content of all technical publications issued by the Society. At least one individual from each local society shall be designated by the local society as an editor to screen and secure suitable material for publication and to act as liaison directly with the Editorial Board.

Section 10

There shall be an Advisory Council appointed by the President with the approval of the Board to lend any assistance requested by the Society in carrying out its purposes as outlined in Article II — Section I.

Section 11

There shall be an Executive Committee composed of the President, Vice President, Executive Secretary, Treasurer, Chairman of the Editorial Board and six members of the Board of Directors. The six members (or their alternates) shall be selected in the following manner: The Directors of the local societies within a geographical district shall determine which of their own number will represent their district on the Executive Committee. The Executive Committee shall possess and exercise all of the powers of the Board of Directors in the management of the affairs of the Society during the intervals between the meetings of the Board of Directors. Each Executive Committee Director shall cast the total votes of all societies included within his geographical district. The boundaries of each geographical district shall be determined by the Board of Directors.

Article V — Meetings and Quorum

Section 1

The annual Meeting of the Society shall be held the fourth Friday in June, commencing in 1947 at a place designated by the Board. Meetings of the Board shall be held at such times and places as the Board may determine, or upon call of the President, and shall be called by the President at the written request of five or more members thereof. The Executive Committee shall meet at such times and places as it may designate or upon call by the President.

Section 2

At regular and other meetings of the Board, a quorum shall consist of the authorized representatives from one-third of the local societies. At Executive Committee meetings, at least two Officers and three Directors shall constitute a quorum.

Article VI — Elections

Section 1

The method of selections of all officers for 1946 shall be by election (for the balance of 1946 and the period ending June, 1947) at an Organization meeting, by majority vote of the duly authorized representative from each society. Voting power of each representative shall be equivalent to the number of members in good standing in the society which he represents.

Section 2

Nominations for the period commencing July 1, 1947 and thereafter for all officers, shall be made by a Nominating Committee appointed by the President, from the Board of Directors. One committeeman shall be appointed from each geographical district. The Nominating Committee shall, at least two months before the Annual Meeting, name one or more candidates for President, Vice President, Executive Secretary, and Treasurer for the ensuing year. Independent nominations may be made by any local society by petition sent to the Executive Secretary at least forty-five days prior to the annual meeting.

Section 3

Thirty days before the Annual Meeting the Executive Secretary of the Society shall mail to all qualified voters an official ballot on which are listed all eligible candidates. Voting may be by person or mail but shall be by secret ballot. The President shall appoint three judges of elections who shall count the ballots. The person for whom a plurality of votes is cast will be declared elected by the judges of election. The judges of election shall decide any question that may arise concerning the validity of any ballot and shall declare the results of the elections. The newly elected Officers and Directors shall begin their terms immediately following the close of the Annual Meeting.

Section 4

Each Officer and Director shall hold office until the appointment or election of his successor.

Section 5

The President and Vice President shall not be eligible to succeed themselves in the same office.

Section 6

One-half of the Directors' terms shall expire June 30, 1947, and the balance one year later. Thereafter, the terms for all Directors shall be for two years. The terms for one-half of the Directors on the Executive Committee shall also extend and expire in like manner. The Board of Directors shall determine the initial length of term for each Director.

Article VII — Amendments

Section 1

This Constitution and By-Laws shall become effective upon ratification by the majority of the votes as represented by the authorized representatives of the local societies attending the Organization Meeting.

Section 2

This Constitution and By-Laws may be amended at any time by an affirmative two-thirds of the votes cast in person or by mail, on a proposal to amend, provided notice of such proposed amendment is submitted to the Executive Secretary at least forty-five days prior to the proposed closing date for the balloting, and provided the proposal is sent by mail at least thirty days before the closing date to each member of the Society qualified to vote.

TRANSITION FROM SUBSCRIBERS TO MEMBERS

The Constitution of the American Society for Quality Control provides for two types of membership:

(1) Members of local affiliated societies who are certified to the Executive Secretary of the Society and for whom three dollars dues have been remitted to the Society Treasurer by the local society.

(2) Members not associated with local societies who remit five dollars dues directly to the Treasurer of the Society (name and address, page 2.) Under this heading subscriptions to INDUSTRIAL QUALITY CONTROL will be received from Libraries and like institutions at the regular five dollar rate. Likewise, individual members and institutions in countries other than the United States and Canada should remit five dollars in United States funds directly to the Treasurer of the Society.

As stated previously, INDUSTRIAL QUALITY CONTROL is now the property of the American Society for Quality Control and henceforth will be published by the Society. Copies of the magazine will be sent to all members of the Society as one of the privileges of membership. This means that subscriptions to the magazine from individuals will no longer be available at the two dollar rate which has been offered to most subscribers in recent months. The terms of the transfer, however, provide for the fulfillment of all existing subscription obligations. Believing that subscribers are entitled to more specific information on the application of this provision, the following plan has been set up by the Executive Committee of the American Society.

Subscribers whose subscriptions expire with the March, May, July or September 1946 issues of the magazine will be offered an opportunity to join the American Society either through affiliation with a local society of their choice or by sending five dollars directly to the American Society. For all four of these expiration dates the payment of dues will maintain membership in the American Society until the end of the Society's fiscal year, June 30, 1947.

Subscribers whose subscriptions expire with the November 1946 or January 1947 issue of the magazine will be offered the same opportunity to join the American Society, but for these two expiration dates the payment of dues will maintain membership in the Society until the end of the Society's fiscal year, June 30, 1948.

The Executive Committee believes that this plan will facilitate the transfer of the present scattered subscription expiration dates to uniform expiration of memberships at the close of the Society's fiscal years on June 30.

The Executive Committee has not attempted to deal with the cases of present subscribers to the magazine who are also dues paying members of local societies. Each individual society should make its own decisions concerning these cases.

There is one very important circumstance affecting this transfer which should be known by subscribers. During the year and one-half that INDUSTRIAL QUALITY CONTROL has been published as a joint venture of the Society of Quality Control Engineers and the University of Buffalo the amount of money paid out for printing, mailing and office expenses has exceeded the money received from subscriptions. This net operating loss is recoverable in the future from the sales of back issues, as indicated in the accompanying Exhibit A. However, one element of cost is omitted from this statement. The University of Buffalo has contributed secretarial service,

(Continued to Page 11)

WHAT DOES MANAGEMENT EXPECT FROM QUALITY CONTROL?

MYRON J. HAYES

EASTMAN KODAK COMPANY

(Address presented at the Second Annual Quality Control Clinic, Rochester, New York, February 19, 1946)

I have followed with interest the work of the Quality Control Engineers of Rochester, which has shown a very healthy growth pattern, both in membership and program.

Your subject interest today, "What does Management expect from Quality Control?" is timely from Management's point of view, too. What can Quality Control do for Management?

Assuming that Management feels that the results of Quality Control justify the cost, then it must exercise patience during the development and perfection of the work, and endure the meticulous and very expensive methods which, in some cases, Quality Control Engineers' charts and records have piled up. At any rate, many Managers were no doubt more comfortable in their feelings with such an outfit than they would have been without them. Quality Control methods aided greatly in maintaining the reputation for quality in precision of many Companies.

During the past few months we have been adjusting ourselves for the long pull of business ahead. Before the war, before your Society was born, and the early beginnieg of statistical techniques in the early 20's by Dr. Walter Shewhart, inspection was a definite and well-known term. Quality Control was not well known. Inspection did excellent service and is still—will always be—useful to production processes.

Quality Control, which implies the scientific approach, is better known now, but not known so well as it will be in the future. Quality Control in the industrial field is an important modern discovery and compares favorably with important discoveries in other fields—good in itself—preventive, protective and curative by its very nature. We see Quality Control as a cost reduction method—as a productive force—a creator of wealth, in that it improves value in products.

There have been many instances in the meetings of this group during the past season where the economics of Quality Control has been demonstrated. It must be apparent by this time that the specialization of refined industrial organization requires a mechanism to carry the early inception ideas, embodied in a commodity by its inventor, to the user. Further, too, skill—for which industry for generations has always paid a premium—is not always evenly applied and, until now, no accepted means of measurement has been proposed.

Management is interested in all of the aspects of operating efficiency as it relates to the productivity of the plant facilities. Inspection adds a new cost factor. This, in a sense, is additional cost, when we consider that it is over and above the cost of performing the actual production operations of producing materials, parts, sub-assemblies, and finished products. However, the addition of this cost saves in the overall result. The control through ratios of inspection to direct productive operators usually varies—we know—with the complications and accuracies involved, but the ratios which were accepted before the war, during the war, and even now—cannot—or should not, at least—continue indefinitely.

Management would like a group—call it Quality Control—to which it could turn over a new untried product—or gadget, if you will—which would put the unfamiliar through a series of checks and give an answer—green light, go ahead—or red light, stop—together with a good analysis of eny problems involved.

The Chemical group has the blue litmus paper test, which turns red in the presence of acid. That is definite—it is good.

The Quality Control group has developed its chart methods of control which tell us when a process is out of control. That is definite—it is good.

You have the Dodge-Romig tables for sample sizes. All of these help to reduce inspection costs to the lowest possible point, consistent with probability of failure. That is definite—it is good.

There is a definite field of investigation indicated in the study of inspection, spoiled work, re-operation and salvage. These are waste items—either Quality Control techniques or some other techniques should be applied, in the future, to control them within acceptable bounds. It is inherent good quality that you men are after—quality that comes when we avoid errors by the elimination of their causes. Certainly, any product is better if it never has to be torn down and put back together again.

Any response to the subject—"What does Management expect of Quality Control?" should include some comments on what a Quality Control Engineer ought to know and what services he is expected to render.

In respect to his knowledge—successful Quality Engineers should have a rather complete knowledge of the business—particularly of design, tooling and gaging, machine practice, assembling and testing methods, competitive developments and consumers' market requirements—and general economics, concerning schedules, costs and quality. They must be strong on statistical methods from the standpoint of understanding, recognizing when a situation requires intensive applications of the principles of advanced Quality Control mathematical applications, in much the same manner as a general court lawyer recognizes when he needs, possibly,

a contract lawyer's technique when approaching the complications encountered in the specialized field of contract law. Too much mathematics—and not enough general knowledge application—could result in grave failure in the effectiveness of the Quality Control Engineer's work.

In his relations with other groups —Quality Control engineer can and does work with the Purchasing Department in the establishment of proper vendor understanding of quality requirements in raw materials and components for product;

(can and does work)—with Production in controlling parts, sub-assemblies, and finished goods so that no additional work is done on already defective pieces;

(can and does work)—with Process Engineers in the establishment and correction of methods to produce better quality without additional cost;

(can and does work)—with inspection in laying out of inspection procedures and stations—sees that the minimum inspection is used, consistent with the quality of the process and the desired outgoing quality;

(can and does work)—with the Sales Department in assuring proper product quality to the customer;

(can and does work)—with the Repair and Service Departments and the customer by analyzing customer complaints and desires, and following through to see that the necessary corrective steps are taken and changes in design made.

Quality Control should and does function from the initial stages of design to the final product in the hands of the customer.

The Quality Control group can furnish factual information regarding exact working limits possible in production machining, for the guidance of design engineers in the establishment of working tolerances on the drawings;

—can furnish complete inspection and testing procedure data which can be an invaluable guide to production personnel;

—can give the best guarantee to Management that the material moving through the manufacturing processes will be useful in the completed product;

—by working closely with outside suppliers, through the Procurement Division, can improve vendor goodwill relationships;

—can be an aid by which Management can obtain customer confidence, customer goodwill—which is in reality the public goodwill;

—can also be the means of training quality consciousness inside an organization.

I should like to comment for a few moments on the aspects of collaboration with other professional groups, such as the Purchasing Agents Association, Society of Tool Engineers, Electrical and Metallurgical groups, Production Managers, and the National Association of Accountants—there are others, too. As a matter of policy of your Steering Committee, I suggest that you select two or three men from your group to speak before these groups at two or three of their meetings. Your speakers could coordinate their subjects in a manner that would give these other groups a comprehensive understanding of the work Quality Control Engineers are doing in their field. Such an action on your part would enable them to visualize the tie-in within their own respective Companies. Some of this has been done, I know, but I cannot over-emphasize the advantages of your group taking the initiative. A natural result would be that qualified speakers from the other groups would accept invitations to speak before your group.

I am mentioning this because I am thinking about the future of the Quality Control Engineer. Cooperation—complete cooperation—with all operating departments of an industry will require that all of the members of an organization have a complete working knowledge of the techniques of the Quality Control Engineer. Considerable research in the application of your techniques to all phases of industry should be pursued. One of the claims of the application of statistical methods is—"If it can be counted or weighed—it can be controlled statistically—at a saving." The concept, "uniformity," whether applied to a high level of quality or to low level of quality, is one of the most significant things to accomplish. There is then a state of control which can be coped with in either direction.

There is one more important angle which ought to be touched on before I sum up.

The measurement of the progress and effectiveness of the work of Quality Control and inspection can be done in a number of different ways,—each industry has its own—counting people — or dollars — against products—sections—sales—growth or shrinkage against past performance.

Your group could do a valuable service to industry if you could establish formulas or other basic data which indicate the proper or normal ratios required for certain combinations of circumstances.

We are in a peace-time economy —after having come through the war with certain new skills and know-how—in conjunction with many technological changes. The fact that industry has been able to take a batch of specifications and drawings of entirely new and strange devices, and produce them to very high precision standards successfully, proves that—out of our war contracts—has developed a method of dealing with new items, especially, and the experience to carry us to even greater success in manufacturing our own products. This is a great accomplishment of the coordinated efforts of many forces working together and should give us great confidence in the future.

In conclusion, then—sorting is outmoded. Industry is always ready to adopt methods like those used in Quality Control, but—to be of lasting importance—there should be no overlapping or duplication of the efforts of others. We can assume that dependable, satisfactory merchandise is the goal of successful Companies and that, likewise, successful Management is interested in every idea or method that will accomplish that result. I urge you to pursue these things energetically and with enthusiasm — I'm equally sure you will have Management's support in your efforts.

Quality Control should be a method that measures conformance results in a product in which your Sales and Advertising forces and your public can have full confidence because they know that the quality warranty is based on precise factory knowledge—gained

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ON THE SELECTION OF AN INSPECTION PLAN

A. J. KAVANAGH

AMERICAN OPTICAL COMPANY, SCIENTIFIC INSTRUMENT DIVISION

Inspection is carried on to save expense. It does this in two ways: by keeping tabs on the production process, to see that production of defectives is kept down to a reasonable amount; and by helping to eliminate defectives already present in product made in the plant or offered for acceptance by a vendor. In this discussion we shall be concerned with the choice of an inspection plan to be used to eliminate defectives from product already made.

The desirability of an inspection plan obviously depends on whether the plan can be expected to save more than it costs. A decision between two plans should depend on a comparison of the net savings which the two can be expected to cause. It is necessary to make an estimate of cost of inspection and of savings which will be effected, if an intelligent choice is to be made.

The elimination of defective material causes several sorts of saving. If the material is being offered by a vendor, the purchaser is saved the cost of the defectives removed. If the material is to be processed further before sale, a waste of labor and further material is avoided. If the defectives are likely to go out to customers, the expenses of customer complaints and of loss of good will are avoided. The last type of saving is hard to evaluate in dollars and cents, so we shall consider mainly the other types, for which it is possible to make a reasonable estimate. However, it is worth noting that the decision to establish a final inspection is in effect a decision that the cost of inspection is less than the expense of customer complaints and of loss of good will which would otherwise occur.

The estimate of saving by removing a defective should include all expense likely to result from failing to remove it. If the material is being offered by a vendor the price which would be paid for the defective should be included, unless the purchaser has the right of subsequent return of rejects. If the material is a product of the concern doing the inspecting the cost of production should not be included, since the loss has already been incurred and cannot be regained. The value of labor and material which would be wasted in trying to use the defective should be counted in, including clerical work and other overhead in connection with replacement or rejection at any later stage.

The estimate of the cost of removing a defective by inspection must be obtained by dividing the expected cost of the inspection process by the number of defectives which it can be expected to remove. We must consider this question in some detail.

Estimate of the total cost of the inspection must include all the expense necessary to carry out the inspection, including such items as extra supervision, added maintenance expense and clerical work. In most cases it probably will be found sufficiently accurate to assume that the cost is in direct proportion to the amount of inspection carried out, so that it costs for example 5 times as much to inspect 1000 pieces as it does to inspect 200 pieces. Only such cases will be considered here, though the general principles involved can be extended to more complicated situations.

Whatever inspection plan is being considered, we can estimate the amount of inspection it will require and the number of defectives it will eliminate only if we know something about the tendency of the production process to make defectives. Ideally we would like to know that the process is in statistical control, and at what level. We could then estimate with confidence in the reliability of our result. Unfortunately, of course, many processes are not in control. Even in such cases, though, it is often possible to say, "The process is worse than one at such and such a level of control," or, "It is better than one at such and such a level of control." When this is true it may still be possible to draw helpful conclusions. So now we look into the amount of inspection required, and the number of defectives removed, by sampling lots taken from a **Process in statistical control.**

Investigation of the principles of sampling in such a case yields a surprising result. We receive product from our process in lots of size **N**, say, and inspect a sample of **n** pieces from each lot. In the course of time we will expect to find some samples with no defectives, some with 1, some with 2, and so on. Let us consider the lots from which the sample yields, say, exactly 4 defectives. What can we conclude about the probable composition of the remaining, uninspected **N-n** items of the lot? The surprising thing is that it can be shown that this remaining portion will, on the average, be no better and no worse than the corresponding portions of lots whose samples yield any other number of defectives. The per cent defective in this portion will in fact in the long run be exactly the same as the per cent defective, or process average, of the production process. From a slightly different point of view, we know nothing more about the uninspected portion of the lot than we would if we had taken an equal number of units directly from the unsampled product of the process.

Let us now consider setting up an inspection plan in which we accept all the lots of which the sample yields, say, 3 or less defectives, and reject or detail those of which the sample yields 4 or more defectives. Obviously the uninspected items which we hold out for rejection or detailing are no worse than the uninspected items we accept.

All we have accomplished is the screening out of the defectives found in the samples.

The result is the same if we apply a scheme of double sampling or even so-called "sequential sampling." The average quality of the uninspected items held out after the first inspection is exactly the same as that of the process. We take another sample and accept some lots and hold out others, but the average quality of the uninspected portions held out is still the same as that of the accepted ones and of the process, and so on for any number of samplings. All we really accomplish is the screening out of the defectives in the samples.

From the same principles it follows that the number of defectives screened out equals the number of items inspected times the process average per cent defective. Consequently we have this important result: the cost of removing a defective equals the cost of inspecting one item, divided by the average per cent defective of the process. Further, this unit cost is the same, regardless of what sampling plan we consider, or even if we go to 100% inspection.

Decision on an inspection plan is now fairly simple. If eliminating a defective is found to be less expensive than trying to use it, as many defectives should be removed as possible. This means 100% inspection. On the other hand if eliminating a defective is more expensive than the cost from leaving it in the product, there is no point in eliminating defectives and no inspection is indicated. (Actually of course it is desirable to do some inspection to make sure that the process remains in control. This should be recognized for what it is, however: inspection for process control and not for economical elimination of defectives already produced.)

In the foregoing we have tacitly assumed that errors by inspectors are negligible. If information on inspector efficiency is available, it should be used to obtain an improved estimate of the cost of removing a defective.

When it is not known that the production process is in control it may still be known that its tendency to produce defectives is greater than that of a controlled process for which 100% inspection would be economical. Then certainly a 100% inspection will result in a net saving, though it may or may not be the most efficient scheme which can be devised. Unfortunately when we do not know that the process is in control we frequently do not have enough information to decide what other plan will result in greater saving.

Similarly it may be known that a process, though not in control, is unlikely to produce defectives at a rate as high as that of a controlled process for which it would be unprofitable to inspect. In such a case it certainly would be unprofitable to inspect 100%. We can not even set up a sampling scheme with assurance that it will be profitable unless we have some knowledge of the probable distribution of the defectives among the lots, and if the process is not in control we frequently do not have that knowledge.

To summarize, the problem of choosing an inspection plan for removing defectives from product can be approached as follows.

1. Estimate as closely as possible the expense which results, on the average, from failure to remove a defective.
2. Estimate as closely as possible the average cost of inspecting one unit of product.
3. Decide whether the process is in control. If it is, determine at what level of average per cent defective. Divide the cost of inspecting one unit of product by this process average. The quotient represents the cost of eliminating one defective by inspection.
   a. If the cost of eliminating a defective is less than the average expense which will result from failing to remove one, decide to inspect the product 100%.
   b. If the cost of eliminating a defective is greater than the average expense which will result from failing to remove one, no inspection is justified so far as economical removal of defectives is concerned. (Any decision to inspect must then be made on the basis of making sure that the process remains in control.)
4. If the process is not known to be in control, but is known to be worse than a controlled process for which 100% inspection would be profitable, then it will be profitable to inspect 100%.
5. If the process is not known to be in control, but is known to be better than a controlled process for which no inspection would be profitable, there is probably no basis for setting up an inspection scheme which would be profitable.
6. If the process cannot be classified under 3. 4. or 5. further knowledge must be obtained as the basis for a decision.

Transition from Subscribers

(Continued from Page 7)

office space and equipment, and the time of the editor to this project. It seems fair to state, therefore, that the two dollar rate was made possible only by an underlying subsidy.

Now that the American Society and INDUSTRIAL QUALITY CONTROL propose to operate on a self-supporting basis, it will be obvious that the semi-subsidized two dollar subscription rate must be superseded by a more substantial rate. At the same time the magazine will be increased in size and the quality of the editorial work will be improved through two major changes: (1) the establishment of an Editorial Board, (2) the gradual divorcing of the business management of the magazine from the editorial function.

What Does Management Expect?

(Continued from Page 9)

through **precise** Quality Control methods.

I congratulate you on the program you have arranged here for your Second Annual Quality Control Clinic. This type of activity is a very constructive force in the development of your growing profession.

The U. S. Army Quartermaster Corps' Use Of Sequential Sampling Inspection

NORBERT L. ENRICK

FORMERLY WITH HEADQUARTERS, QMC INSPECTON SERVICE

The Quartermaster Corps Inspection Service, during the latter part of this war, has used sequential sampling for quality control in acceptance inspection at many thousand plants of Army suppliers.

How sequential sampling can achieve a desired quality protection with considerably less inspection than standard methods has been shown by Dr. Freeman in the September, 1945 issue of INDUSTRIAL QUALITY CONTROL. However, whether this type of sampling is practical in large scale inspection has often been questioned. The accomplishments of the QMC Inspection Service are proof of the practical usefulness of the sequential method, at least under percent-defective inspection (go-not-go).

Most Quartermaster items have quality characteristics which, if not fulfilled according to specifications, result merely in less effective functioning of the defective article. Thus, there may be "major" or "minor" defects, but the possibility of "critical" defects endangering the life of the soldier are absent. This fact makes most Quartermaster items very well suited for acceptance based on standard sampling plans. The advantages of sampling, where applicable, over 100% inspection in acceptance of Army material have been well established in the published experience of the Army Ordnance Department.

Acceptable Quality Level

As in the Ordnance Department, application of lot-by-lot acceptance inspection by the QMC at contractors' plants hinges about adoption of an Acceptable Quality Level (AQL) for each item involved. The AQL is the highest percentage of defectives which the contractor's product may contain and yet be considered acceptable by the QMC. In determining the value of a particular AQL, recognition was given to the fact that in service conditions "enough and on time" is just as important as quality. A carefully selected AQL, therefore, should represent a delicately balanced triangle between the quality needed, the quantity needed, and the quality obtainable under given conditions. Accordingly, a statistical analysis of inspection data, the supply situation and technological data form the background of a particular value of an AQL.

Sampling Plans

After an AQL has been established for an item, QMC inspectors at contractors' plants are furnished with standard sampling plans based on this value. A sampling plan gives the inspector sets of three all important numbers:

1. Sample Size — the number of articles to be examined out of each lot.
2. Acceptance No. — If defectives up to this number are found in the **sample,** the **lot** must still be accepted.
3. Rejection No. — if this number or more defectives are found in the **sample,** the **lot** is rejected.

The following is an example of a sampling table for an AQL of 2% and an inspection lot consisting of from 800 to 1299 articles:

SAMPLE SIZE (Cumulative)	ACCEPTANCE NO. (Cumulative)	REJECTION NO. (Cumulative)
40	0	4
60	1	5
80	2	6
100	2	6
120	3	7
160	7	8

The gap between the acceptance and rejection numbers forms an area of indecision, meaning that if the number of defectives found falls into this gap an additional sample must be taken. For example, if an inspector has found one defective in his first sample of 40, he can neither accept nor reject the lot, since the acceptance number is 0 and the rejection number 4. So, the inspector must take another sample of 20, bringing his total sample size to 60 (40 plus 20). Again, the inspector will compare the total number of defectives found up to this point to determine whether to accept or reject the lot or to continue sampling. This process may go on until the highest sample size is reached, 160, at which point the gap between the acceptance and rejection numbers disappears and the problem of acceptability is finally solved.

It is evident that this type of sampling will generally permit very good lots to be accepted and very bad lots to be rejected after the first or second sequential sample. Only lots of in-between quality will, on the average, require more inspection. It has been determined roughly that if a contractor consistently submits lots whose quality equals the AQL, then the average sample size that will be examined by the QMC inspector is approximately half the final sample size in a sequential table.

After sequential sampling is installed at a plant, it may become apparent that the manufacturer is operating at a level of quality which is not acceptable. Such a manufacturer will naturally find himself compelled to improve his product by setting up a better quality control of his own.

Master Tables

In order to eliminate the necessity of computing sampling tables each time quality control is installed at a plant, the QMC prepared master tables[2] (see Table) from which individual tables could be extracted as needed. These tables are designed with the intention of decreasing the risk of rejecting a good lot—one whose quality equals the AQL—as the lot size increases. For the risk of rejecting a large good lot must indeed be small. The QMC Inspection

NORMAL SAMPLING TABLE

LOT SIZE	SAMPLE SIZE	ACCEPTABLE QUALITY LEVEL (Percent Defective)																													
		0.1		0.25		0.50		0.75		1		1.5		2		3		4		5		6		7		8		9		10		12	
		A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
499 or less	40									0	3	0	3	1	4	1	4	1	6	2	6	2	7	3	7	3	8	4	9	4	9	5	10
	50									1	3	1	4	1	4	2	5	2	6	3	7	3	8	4	9	4	9	5	10	5	11	6	12
	60									1	3	1	4	2	5	2	6	3	7	4	8	4	9	5	10	5	11	7	12	7	13	9	14
	70	↓		↓		↓		↓		1	4	2	4	2	5	3	6	4	8	5	9	5	9	6	10	7	11	8	13	8	13	10	16
	80									3	4	3	4	4	5	5	6	7	8	8	9	8	9	9	10	10	11	12	15	12	15	15	16
500 to 799	40									0	3	0	3	0	4	1	5	1	5	1	6	1	7	2	8	2	8	2	9	4	10	4	11
	60									0	3	0	3	1	4	1	5	2	6	2	7	3	8	3	9	4	10	5	11	5	11	6	12
	80									1	3	1	4	1	5	1	6	3	7	3	8	5	10	5	11	6	12	7	13	8	14	9	15
	100	↓		↓		↓		↓		1	4	2	4	2	5	2	6	4	8	5	9	6	11	7	13	8	14	9	16	10	17	12	18
	120									3	4	3	4	4	5	5	6	7	8	8	9	10	11	12	13	13	14	15	16	16	17	18	19
800 to 1299	40							*	2	*	2	*	3	0	3	0	4	0	5	0	6	1	6	1	7	1	8	2	8	2	9	2	10
	60					0	2	0	3	0	3	0	4	1	5	1	6	2	7	2	8	3	9	3	10	4	11	4	12	5	12	6	14
	80					0	3	1	3	1	4	1	5	2	6	2	7	3	8	4	10	5	11	5	12	6	13	8	15	8	15	9	17
	100					0	3	1	3	1	4	1	5	2	6	3	8	5	10	5	11	7	13	7	14	9	15	10	17	10	18	12	21
	120	↓		↓		1	3	2	4	2	5	2	6	3	7	5	9	6	11	7	13	8	14	9	16	11	18	12	19	13	21	15	24
	160					3	4	4	5	4	5	5	6	7	8	9	10	10	11	13	14	15	16	16	17	18	19	19	20	22	23	25	26
1300 to 3199	50			*	2	*	2	*	3	*	3	0	4	0	4	0	5	0	6	1	7	1	8	2	9	2	10	3	10	3	11	5	13
	75			0	2	0	3	0	3	0	4	0	5	1	5	2	7	2	8	3	9	4	10	4	12	5	12	6	14	6	15	7	17
	100			0	2	0	3	1	4	1	4	1	5	2	6	3	8	4	9	5	11	6	12	6	14	8	15	9	17	10	18	11	21
	125			1	3	1	3	1	4	2	5	2	6	3	7	4	9	5	11	7	13	8	15	9	16	11	18	12	20	13	21	15	25
	150	↓		1	3	2	4	2	5	2	5	3	7	4	7	6	10	7	13	9	15	10	17	11	19	14	21	15	23	16	25	19	28
	200			2	3	3	4	4	5	5	6	6	7	6	7	10	11	13	14	17	18	17	18	20	21	22	23	25	26	27	28	31	32
3200 to 7999	50	*	2	*	2	*	2	*	3	*	3	*	4	*	5	0	6	0	7	0	8	1	9	1	10	1	11	2	11	2	12	3	14
	100	*	2	*	2	0	3	0	4	1	4	1	5	1	7	2	8	3	10	4	12	5	13	5	15	6	16	8	17	9	19	10	21
	150	0	2	0	3	1	4	1	5	2	5	2	7	2	8	5	11	5	13	8	15	9	17	10	19	11	21	13	23	15	25	17	29
	200	0	2	1	3	2	4	2	5	3	6	3	8	4	10	7	13	8	16	12	19	13	21	15	24	16	26	19	29	21	31	25	36
	250	1	3	1	4	2	5	2	6	4	8	5	9	6	11	9	15	11	18	15	22	17	25	19	28	22	32	25	35	28	38	32	44
	300	2	3	3	4	4	5	5	6	7	8	8	9	10	11	15	16	17	18	22	23	25	26	29	30	32	35	36	37	39	40	46	46
8000 to 21999	100	*	2	*	3	*	3	*	4	0	5	0	6	0	7	1	9	1	11	3	12	3	14	4	16	5	17	7	18				
	150	*	2	*	3	0	4	0	5	1	6	2	7	2	9	3	11	4	14	6	16	7	17	9	20	10	22	12	24	↑	↑	↑	↑
	200	0	2	0	3	0	5	1	6	2	7	3	8	5	10	6	13	7	17	10	19	11	22	13	24	16	27	18	30				
	250	0	2	0	4	1	5	2	6	2	8	4	9	5	12	8	16	10	19	13	22	15	25	18	29	19	32	24	35				
	300	0	3	1	4	2	6	2	7	3	8	5	11	6	13	10	18	12	22	16	26	19	29	22	33	24	37	29	41				
	400	1	3	1	4	3	7	4	8	5	10	8	14	10	16	14	22	18	27	23	33	27	37	31	42	34	47	40	52				
	500	2	3	3	4	6	7	7	8	9	10	13	14	16	17	22	23	28	29	34	35	40	41	45	46	50	51	58	59				
22000 to 99999	100	*	2	*	3	*	4	*	5	*	6	*	8	0	8	0	11	1	13	2	16	3	16										
	200	*	3	*	4	0	5	0	6	1	7	1	10	3	11	3	15	6	18	8	20	10	24	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
	300	0	3	0	4	1	6	1	8	2	9	3	12	5	14	7	19	11	23	14	26	17	31										
	400	0	3	1	5	2	7	3	9	4	11	5	14	8	17	11	23	16	28	21	33	25	39										
	600	1	4	2	6	3	9	5	11	7	14	10	18	14	23	19	31	27	38	34	46	39	53										
	800	1	4	3	7	5	11	8	14	11	17	14	23	20	28	27	38	37	49	46	58	54	68										
	1000	3	4	6	7	10	11	13	14	17	18	22	23	30	31	40	41	53	54	65	66	76	77										
100,000 and up	200	*	3	*	5	*	7	*	8	0	9	0	13	2	13	2	18	4	20														
	400	*	4	0	6	0	8	0	10	3	12	3	17	7	18	9	25	14	30	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
	600	0	4	1	7	2	10	2	12	5	15	7	20	18	22	17	33	24	40														
	800	1	5	2	8	4	11	5	14	8	18	11	24	18	29	24	40	34	50														
	1000	1	5	3	9	5	13	7	17	11	21	15	28	23	35	32	47	44	60														
	1200	2	5	3	9	7	15	9	19	14	24	19	32	28	40	39	55	54	70														
	1600	4	5	8	9	14	15	19	20	24	25	33	34	45	46	61	62	86	87														

A - Acceptance number
R - Rejection number
*** Acceptance cannot be made at this sample size**
↓ Use first sampling table below arrows (Form larger lots, if necessary)
↑ Use first sampling table above arrows

Manual on "Sampling for Quality Control"[2] lists these risks as follows:

Lot Size	Aproximate* Risk of Rejection
3,199 or less	5%
3,200 to 7,999	4%
8,000 to 21,999	3%
22,000 to 99,999	2%
100,000 and up	1%

* Technical Note: These risks are only approximate, having been calculated on the assumption of a true sequential scheme while the sampling tables themselves represent grouped and truncated schemes.3 Even though the future may bring some adjustments of the master tables, they are nevertheless useful tools in their present form.

The sampling tables shown (Normal Tables) give the contractor the benefit of the doubt as regards sampling risks. As a result, it is possible that a contractor may, for some time, present lots of slightly sub-standard quality and yet experience no rejections. To overcome this weakness of normal sampling tables, process averages are computed regularly. On the basis of process average data, such plants are subjected to "protective sampling" which is based on tighter acceptance and rejection numbers than normal tables, thus giving the Army more protection. Protective tables are so calculated that if the producer reinspects and resubmits all rejected lots after 100% screening, then the average outgoing quality of all materials accepted under protective sampling will not exceed the Acceptible Quality Level.

The following is an example of a protective table for lots of 800 to 1,299, AQL 2%:

SAMPLE SIZE (Cumulative)	ACCEPTANCE NO. (Cumulative)	REJECTION NO. (Cumulative)
40	0	3
60	0	4
80	1	5
100	1	5
120	2	6
160	5	6

If a contractor has been consistently submitting product of superior quality, the QMC inspector at his plant is furnished with a reduced sampling table, such as the following for lots of 800 to 1,299, AQL 2%, but a close check is maintained over the process average:

SAMPLE SIZE (Cumulative)	ACCEPTANCE NO. (Cumulative)	REJECTION NO. (Cumulative)
20	1	‡
40	1	4
60	1	5
80	2	6
100	2	6
120	3	7
160	7	8

‡—"Rejection cannot be made at this sample size."

Evaluation of Results

Detailed statistics as to the savings in inspection due to sequential sampling are not available, for other inspection saving devices played an important role: gages, templets, technical handbooks, etc. However, the following quotation from a speech in the summer of 1945 by Colonel Vere Painter, Officer-in-Charge of Inspection Service Headquarters throws some light on this subject:

> "We have had a 40% increase in workload in the past six months with a 5% increase in personnel . . . I do not believe there is any doubt but that the use of sampling plans has assisted us greatly in carrying this load."

That this saving of inspection was by no means due to superficialty of coverage is borne out by figures showing considerable improvement in quality following introduction of sequential sampling plans.

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2. "QMC Inspection Handbook on Sampling for Quality Control," QMC M-608 15 (1944/5).
3. "Sequential Analysis of Statistical Data: Applications." Statistical Research Group, Columbia Univ. (1944).
4. "Sequential Sampling Inspection for Attributes," H. A. Freeman, Industrial Quality Control, September, 1945.

CONTROL LIMITS WITH ALLOWANCES FOR KNOWN VARIABLES

(Synopsis of a paper delivered before the Society of Quality Control Engineers at Buffalo, N. Y., February 25, 1946, by WARREN R. PURCELL, President, Boston Society for Quality Control and Supervisor of Lamp Test, Sylvania Electric Products, Inc., Salem, Mass.)

The conventional control limits for averages are based on the premise that it is economically sound to try to eliminate from a process all the time to time variables, and thus to reduce all variability to that due to the constant system of chance causes.

It has become well established, however, that in many machine processes it is more economical to broaden the limits to allow for the time to time variation caused by tool wear. There are many other processes which contain non-uniform cause systems that cannot be economically eliminated.

Many of the non-uniform products resulting from these processes are the raw materials of other manufacturers. In some cases they materially affect the final characteristics of the second manufacturer's product. In these cases the second manufacturer should not try to control his product within conventional limits. Instead he should broaden his control limits to allow for the known variation in his product that will be caused by the known variation in his raw materials.

A specific illustration of this principle is found in the manufacture of incandescent lamps. The final characteristics of lamps are materially affected by the diameter of the tungsten wire of the filament and of the mandrel on which it was wound.

The process of drawing wire contains a non-uniform cause system. For the short time variation within a single die is small compared to the variations between dies or within one die during a longer period. It is not economically sound to try to eliminate this non-uniform cause system.

It is, therefore, not economically sound to try to control the final characteristics of incandescent lamps within conventional control limits. It is more economical to establish broader limits which allow for the non-uniform cause system.

True economic control of quality is not necessarily the elimination of **all** time to time variables. Rather it is the elimination of all **unknown** time to time variables and an adequate limitation of the effect of the known time to time variables. A processor need not necessarily get statistically uniform materials from his supplier if he can be assured of the maximum amount of time to time variation in his product that will be caused by the maximum amount of time to time variation in his raw materials.

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Society Of Quality Control Engineers In Michigan

Two Interesting Talks Heard by the Detroit Society of Quality Control Engineers at its Regular Meeting

Thursday evening, January 31, found the Detroit Society of Quality Control Engineers enjoying one of its best regular meetings in some time.

An unusually large group of visitors as well as a goodly portion of its regular membership turned out. Guests present numbered 49, while their hosts numbered 38. These together represented 37 companies located in towns as far away as Lansing, Flint, Saginaw, Port Huron, Ann Arbor, and Jackson. A fine program was offered and featured talks by L. W. Rankin of Wilcox-Rich Company, Saginaw, and A. R. Jackson of Curtiss-Wright Corporation, Columbus, Ohio.

Opening the evening's program was the talk by Mr. Rankin of the Wilcox-Rich Company. His speech covered the introduction of Quality Control to his company in 1943, and gave a brief history of the progress and results achieved through its use.

First contact of this organization with quality control was the "Eight-day" course in Detroit. This course enthused the speaker but it still remained to sell management on the idea of using quality control.

Selling quality control to management was simplified by the use of frequency distribution charts. These showed the product having a large deviation from engineering tolerance. Discussion on this problem brought together the General Superintendent, the Chief Engineer and the Quality Control Engineer. The result of this huddle was a trial run under quality control's statistical methods.

The first application was made using $\bar{X}$ and R charts. Results, very soon, were promising as witnessed by a marked improvement in the work.

From these simpler beginnings, the program was expanded to include other operations in the machine shop and to sub-assembly work. Some samples follow.

In one case, double sampling was used on a product which was produced at a rate of 10,000,000 pieces per month. The results showed no complaints registered from the time of its application in January, 1945 to the end of the war at which time the contract was terminated.

The automatics department which had been somewhat of a problem child showed a scrap decrease from 6% to less than 1% upon the application of quality control.

Then there was the interesting case where almost overnight the rejections from a particular honing machine jumped from 0% to 25%. The $\bar{X}$ and R charts were put on the machine, and the faulty work was pinned down to one shift. Further investigation finally brought out the fact that the operator had taken out one of the hone elements to speed up his production. When this was replaced, production improved to its previous quality level.

Other cases with savings of $2000 per week and improvements of 35% in the quality of the product were cited.

The general conclusion as expressed by Mr. Rankin was that quality control had done much more than earn its own way in the plant, and this to the satisfaction of all concerned.

Mr. Jackson continued the program, after a recess, and gave his audience a most interesting talk on the introduction and history of quality control at the Columbus Plant of Curtiss-Wright. Especial emphasis was placed on their use of Sequential Sampling.

Their first association with quality control was an "eight-day" course at Leland Stanford University in March, 1944. A review of previously gathered statistics and an investigation of the experiences of other airplane manufacturers gave Curtiss-Wright their background on which to work.

The first application of quality control at the Columbus Plant was in the Assembly Department. Here "c" charts were first used on the major problems experienced in the Department.

After a short period remarkable results were shown as indicated by the following statistics:

1. The daily paper load was reduced from over 16 thousand sheets to 920 sheets.
2. The yearly cost of this paper work represented a reduction from over $155,000 to approximately $17,000.
3. Improved quality is indicated by a cut in inspecion personnel from 65 to 38 at a yearly saving of $65,000.
4. Reduction of rework saved $124,000.
5. Inspection at installation was reduced at a saving of $24,000.
6. Subcontractors were pleased with the new setup in that it was possible to summarize results on one page instead of the 480 pages previously required.

Summarizing results, we find a yearly saving of $350,000 and a paper saving of 4,500,000 pages annually in this one department alone.

The work in the Assembly Department was followed by the use of "c" charts elsewhere. One of the departments was the fuselage department, where savings of $165,000 per annum were registered. Finally these charts were used on major assembly breakdown and inspection departments.

A notable feature was the method of handling repetitive "Crabs" and their correction. Department heads were called together and analyzed the causes and the points of blame. After a few of these meetings astonishing improvement was noted in the reduction of "Crabs."

It soon became apparent that to obtain a complete picture of the finished product, similar methods should also be used on receiving inspection. It was decided to use "p" charts for this purpose.

Once again a review of past records was made and a quality level was established from these.

Inspection tables were subsequently built up on the basis of Dodge-Romig double sampling inspection. Accurate records were kept and from these it was possible to get a complete overall picture of the various vendors and their products. Due to the large amount of inspection required of this plant, the disadvantages of the Dodge-Romig tables soon became apparent.

This led to additional investigation and eventually to the system of Sequential Sampling. Mr. Jackson's explanation of this system was new to many of the Society's members and proved most interesting and lucid. Sequential sampling was indicated to be a means of obtaining the maximum of assurance out of a minimum amount of sampling.

This system is predicated on four chosen values listed below:

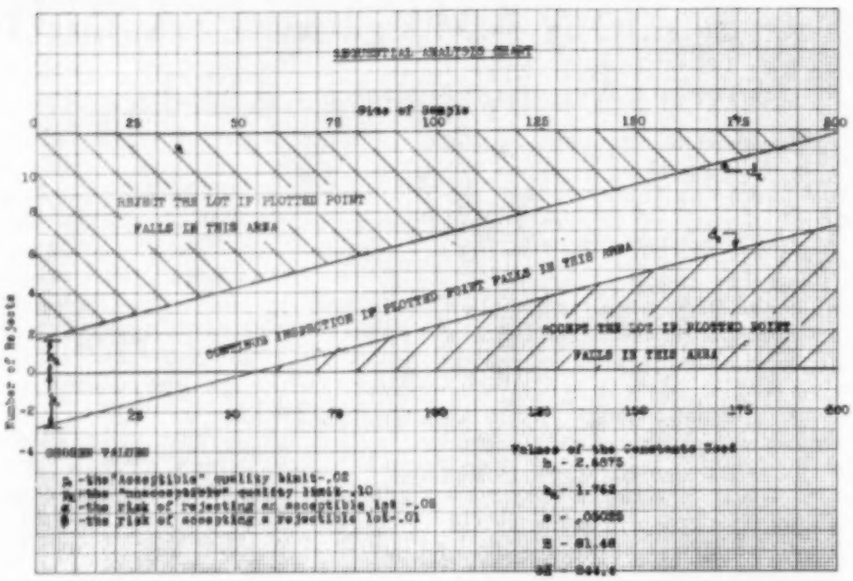
1. An "Acceptable Quality Level" symbolized by p_1.
2. An "Unacceptable Quality Level" symbolized by p_2.
3. The risk of rejecting an acceptable lot symbolized by alpha (α).
4. The risk of accepting a rejectable lot symbolized by beta (β).

Under this system some outstanding features are noted. For one thing the final sample size is left undetermined. Inspection continues until an assurance is reached as to whether the lot should be accepted or rejected. Another feature lies in the fact that the information required for one set of standards can be plotted on a single graph.

A typical graph is shown in the accompanying sketch.

Acceptance usually could be made on the basis of 54 samples while in certain cases it would be possible to reject a lot on the basis of two pieces provided these were both defectives. However, it was decided to require a minimum inspection of 54 pieces, thereby being assured of an honest and representative sampling, and also it gave the vendors less opportunity for criticism.

An examination of the chart shows that rejections can be made on 2 defectives in 2 samples, 3 defectives in 5, 4 in 25, 5 in 45, etc. as these points fall in the "reject" area. Acceptance can be made on


Size of Sample
REJECT THE LOT IF PLOTTED POINT
FALLS IN THIS AREA
CONTINUE INSPECTION IF PLOTTED POINT FALLS IN THIS AREA
ACCEPT THE LOT IF PLOTTED POINT
FALLS IN THIS AREA
Number of Rejects

0 defectives in 54 samples, 1 defective in 74, 3 in 114, 4 in 134, etc. since these points fall in the "accept" area. In the case where 1 defective was found in the sample of 54 pieces, additional sampling would be required such that a plotted point would fall in either the "accept" or "reject" area.

When the inspection was completed on a given lot, the results were indicated and recorded, and the material was either "Accepted as is" or sent to Material Review department for their decision as to its disposition.

Inspection records were kept and classified both according to vendors and according to parts. This information was then assimilated into monthly reports, which soon gave the clues as to who were the more reliable vendors and this in turn improved the finished product.

By means of this system, it was possible materially to reduce the amount of inspection required. Actually it was possible to pass judgment on the basis of 54 samples in 98.3% of the cases. That this system proved reliable was attested to by the fact that the quality level of the product rose from 93% in December, 1944 to 97.9% in May, 1945 and no single justifiable complaint was received from either the vendor or from within the plant.

From receiving inspection the system spread to use in many other places in the plant with equally encouraging results. These, too, were summarized in Mr. Jackson's talk.

THE ROCHESTER CLINIC

The second annual Quality Control Clinic sponsored jointly by the Rochester Quality Control Engineers and the Industrial Management Council of Rochester was held February 19 at the Rochester Chamber of Commerce. More than 450 persons attended the luncheon and dinner meetings, and about 350 attended the Clinics during the afternoon.

The speaker at the luncheon was Mr. Myron J. Hayes, Vice President and General Manager, Camera Works and Hawk-Eye Works, Eastman Kodak Company. His talk, which is printed on pages 8 and 9 of this magazine, was very well received.

The reports of the eleven clinics held during the afternoon were to be presented in this issue, but space limitations have prevented.

The dinner meeting was a fitting climax to the session. Mr. Andrew I. Peterson, Radio Corporation of America, Vice President, American Society for Quality Control, was at his incomparable best in presenting "Critical Needs in the Quality Control Profession."

REVIEW

SEQUENTIAL ANALYSIS OF STATISTICAL DATA: APPLICATIONS

Prepared by the Statistical Research Group, Columbia University
Published by Columbia University Press, 1945, $6.25

Reviewed by Edward Close
Bausch & Lomb Optical Co.

It has been said, "Necessity is the mother of invention." So the necessity for quick and accurate decisions in wartime started a chain of thought which resulted in a technique for making those decisions more quickly to specified degrees of accuracy. This technique, called Sequential Analysis, combines the definitions of the decisions to be made with the risks of making wrong decisions, in the construction of formulas which make those decisions with the fewest observations. The formulas were devised for the specific purpose of deciding on the best method of firing naval shells. In actual operation they have been used as sampling plans for mechanical parts, as tests of significance to determine the better of two manufacturing processes and as tests to determine significant differences between testing procedures. Their possible uses are unlimited.

Initially information on the subject was published by A. Wald under the title "Sequential Tests of Statistical Hypotheses," Annals of Mathematical Statistics, Volume 16, No. 2, June 1945. This article gives the basic theory and shows how to adapt it to a variety of problems. It is not, however, the final solution for the average shop man. It presents him with the still greater problem of understanding all of the mathematical deductions which make up the theory before he can apply it to a practical problem.

"Sequential Analysis of Statistical Data — Applications," consists of a loose leaf binder containing seven pamphlets, each of which is nearly self-contained and covers a different phase of Sequential Analysis. The pamphlet form suggests that there will be future revisions and additional applications added to the present book. The fact that a section referring to a specific problem may be removed when needed makes for easier handling and quicker reference to tables and charts.

The first pamphlet (Sec. 1) entitled "Sequential Analysis in Inspection and Experimentation" serves as an introduction to the rest of the book. The problems of sampling in inspection and experimentation are described, and the statistician's contribution to the solution of these problems is briefly outlined. This section is non-mathematical and should be required reading for people in industry. It is an excellent resume of problems encountered in sampling, stated in terms that are understood by the layman.

The second section, entitled "Sequential Analysis When the Result of a Single Observation is a Classification as Good or Bad and When the Result of the Test is Acceptance or Rejection," is the one that will become the most shop-worn and dog-eared. It deals with the problem of deciding whether a lot of product is acceptable or unacceptable on the basis of the examination of a portion of the lot.

The sequential plan for sampling inspection establishes criteria for acceptance or rejection based on four values:

- p_1, the "acceptable" quality level for the lot.
- p_2, the "unacceptable" quality level for the lot.
- α, the maximum risk or probability of rejecting lots of p_1 quality or better.
- β, the maximum risk or probability of accepting a lot of p_2 quality or worse.

These are the values the user must decide upon before he can construct a sequential sampling plan. The book gives all of the equations and tables necessary to construct the acceptance or rejection criteria from these four values.

Considerable space is devoted to the formulation of operating characteristic curves, average sample size curves and average outgoing quality curves for the sequential plan. While a certain amount of this is necessary, the authors have carried this phase of the subject to a point where it is more of statistical interest than practical. This section contains a comparison of the sequential plan with a standard double sampling plan and submits proof that the sequential plan will accomplish the same results as the standard plan with considerably less inspection.

In summation, this section should be of great value because it presents an entirely new sampling plan which is easily adaptable to specific cases and provides any desired degree of protection.

Section 3—"Sequential Analysis When the Result of a Single Observation is a Classification as Good or Bad and When the Result of the Test is a Decision Between Two Methods or Products."

This section deals with the application of sequential analysis to the problem of choosing between two processes. It is designed to determine which of the two processes yields the more satisfactory results. The sequential method outlined should find many practical uses in industry. Particularly when changes in process or changes in method of manufacture are instituted. It could be a deciding factor in determining whether the new method or process is satisfactory from the quality viewpoint.

Section 4—"Sequential Analysis When the Quality Being Tested is Measured and When the Question is Whether a Standard is Exceeded (or Fallen Short of)."

While Sections 2 and 3 deal with the problems of inspection by attributes, i.e. good or bad, this section and Sections 5 and 6 deal with the application of sequential analysis to variables that are measured. The problem of this section is to decide if the average measurement of a lot submitted differs from a standard or acceptable average in a specified direction.

Section 5—"Sequential Analysis When the Quality Being Tested is Measured and When the Question

(Continued on Page 19)

SOCIETY REPORTS

Philadelphia Quality Control Society

At our January 18 meeting, Mr. E. M. Schrock of the Ordnance Research and Development Center, Aberdeen Proving Ground, read a paper on "Some Comments on the Nature, Meaning and Selection of Samples."

This pointed out: The difference between quantity and quality of information gathered, and the proper evaluation of such data.

That we are apt to follow blindly a formula without a real conception of either the case under observation or an understanding of the answer obtained.

That perfect precision does not exist, but that the deviation from perfection can be reduced so that it is not significant to those concerned.

That it is easier to judge the process than the lot.

At our February 15 meeting, Mr. H. W. Poole of the Brown Instrument Company presented a paper on "The Use of Distribution Curves to Establish Manufacturing Tolerances."

Although applied to establishing a specification for building thermocouples, this same technique can be employed to predetermine manufacturing tolerances.

In making these thermocouples, it was necessary to determine the thermal electromotive force characteristic of the iron tubing and then specify the desired characteristic for the other half of the couple (constantan).

With this selection, it is possible to random-assemble the two parts and come out with a very accurate instrument. It is also possible to use different couples with the same measuring device and maintain this high accuracy.

At this same meeting, F. R. Bailey of the Electric Storage Battery Company described a method of acceptance sampling for soft rubber spacers used in submarine work.

He demonstrated the need for a complete understanding between the manufacturer and the purchaser in regard to methods to be used.

A control chart was used rather than a distribution curve as it was thought the former was easier for everyone to understand. As the work progressed, it was also found convenient to omit some of the usual features of a control chart.

With the material separated into lots of approximately three thousand articles, it was found from actual experiment that there was little, if any, difference in the results obtained from samples varying in size from sixty to two thousand.

There was proof that supposed significant changes in the manufacturing operation did not change the material. This is not an isolated example of such failure.

Ohio Quality Control Society

Our speaker for the February 22 meeting was Mr. W. T. Rogers, Metallurgical Statistician of National Tube Company, Lorain, Ohio. His subject was, "Practical Application of Statistical Methods in a Quality Control Program." He presented examples of the application of statistical methods in the quality control program. Three general methods of handling routine data were discussed; frequency distributions, control charts, and correlation, with a number of actual examples demonstrating each application. The examples were of particular interest to anyone connected with the steel industries as many of them were taken from open hearth and rolling mill operations.

Society of Quality Control Engineers of California

A meeting was held February 26 at 6:30 p. m. in the Tropical Room of Hotel Clark, 426 South Hill Street, Los Angeles, California. Professor P. G. Hoel of the University of California at Los Angeles spoke on "A New Approach to Sampling." This was a presentation of the sequential sampling method. Mr. E. E. Bates of Quality Engineering Corporation spoke on "How to Present Quality Control to Management."

Delaware Quality Control Society

The February 4 dinner meeting was devoted to "The Use of Correlation in Industry." Drs. E. V. Lewis and W. W. Chadbourne gave a demonstration of the use of the calculating machine in computing the product-moment and the two standard deviations which enter into the coefficient of correlation. Having a machine in the meeting for direct demonstration added greatly to this presentation. Mr. W. H. Markwood, Jr. discussed "The Statistical Treatment of Hardness Data." The emphasis here was on the correlation between tensile strength and hardness. This relation permits the substitution of a non-destructive test for a destructive one in most practical cases. One must always be certain, however, that the acceptable range of tensile strength is not exceeded by the predictable variability of the regression equation.

Milwaukee Society for Quality Control

The Milwaukee Society for Quality Control was formerly organized on December 10, 1945 as an outgrowth of the WPB training courses offered to representatives of war industries at various Universities throughout the country during the past two years. The object of this society is to promote interest in and to further the development of industrial quality control in Wisconsin.

Quality control methods have been successfully adopted by both large and small industries for the purpose of improving product quality, labor and material economies, decreasing inspection costs and promoting better producer-consumer relations. These control methods can also be utilized to assist in the standardization of products, machine methods, and inspection methods. In addition they give valuable aid in setting specification limits.

The Society provides for analyzing and exchanging information regarding quality control methods with special emphasis on the statistical method of solution. The individual members review various problems arising in their respective plants and mutually contribute to the solution of the problems involved.

The Milwaukee Society for Quality Control, presently consisting of 50 members, represents leading Milwaukee industries. The recently elected officers are Harold Roethel of Perfex Corp., President; John Iacurto of Eclipse Moulded Products Co., Vice President; and I. W. Schoeninger of Globe Union, Inc., Secretary-Treasurer. Represented on the Board of Directors are Harold Roethel, John Iacurto, I. W. Schoeninger, T. Bingham of Globe Union, Inc., L. H. Collison of Allis-Chalmers, and E. H. Nelson of Automatic Products.

On January 14, 1946 at 6:30 p. m. the Milwaukee Society for Quality Control held its first dinner meeting at the Ambassador Hotel. The guest speakers were Lt. John L. Shafer, USNR, Chicago, who discussed "Acceptance Inspection and Process Control," and Mr. H. A. Wons, Quality Control Engineer, Waukesha, whose subject was, "Instituting a Quality Control Program into the Manufacturing Process." Sixty-five persons attended the meeting.

The next meeting, on the 19th of February, was held jointly with the Milwaukee Chapter of the American Society for Metals at the Milwaukee Athletic Club. The speaker was Joseph Manuele, Director of Quality Control, Westinghouse Electric Corporation. His subject was "Quality Control," and his presentation left little doubt concerning the advantages of a quality control installation in the directions of cost reduction, increased output of acceptable product, better plant relations, and more acute management control.

Mr. Manuele was quite emphatic in stating that quality of product must be the responsibility of the production department, whereas the function of the inspection department is to verify the work done by production.

REVIEW

(Continued from Page 17)

is Whether a Lot Differs from a Standard."

This section applies sequential analysis to the problem of deciding whether the average measurement of a lot, submitted for inspection, differs from the standard in either direction (plus or minus a specified amount).

Section 6—"Sequential Analysis of Variability of Quality About the Average."

Sections 4 and 5 deal with the application of sequential analysis to problems involving the average measurement. This section deals with the problem of variability of the measured quality characteristic in which the quality is defined in terms of standard deviation. It assumes that a smaller standard deviation indicates better quality. Two classes of problems are treated (1) those in which the average measurement is known and (2) those in which the average measurement is not known.

Section 7—Appendices.

This section entitled "Some Properties and Principles of Sequential Analysis" is divided into two parts:

Appendix A offers further evidence of the saving in inspection when a sequential plan is used.

Appendix B explains in an informal and understandable way the fundamental formula from which the various sequential plans were derived. This section should receive careful consideration by users of sequential sampling plans. A knowledge of the background of any sampling plan is a prerequisite for a full understanding of the characteristics of the plan and the risks involved. "Sequential Analysis of Statistical Data" is an understandable presentation of a new technique for sampling inspection. It impresses the reader with the fact that it is a sampling plan which gives adequate assurance of quality at a minimum of cost.

Up to the present time Section 2 has had the greatest amount of practical application, and it has proved advantageous in most cases. At the same time some operators have found that their incoming materials could be inspected at lower cost by other methods.

APOLOGY

The Editor and Printer combine in offering to the Authors involved and to all Readers a most sincere apology for a regrettable error which crept into the Special Management Issue sent to you in January. The first two paragraphs appearing in column 1, at the top of page 3 in Mr. Edward's article, do not belong there. They are part of the article by Mr. Halsey Kent and should have been printed at the end of his article on page 18.

Will you please make note of this correction in your copy.

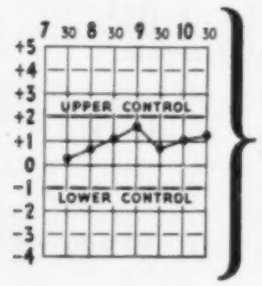
SUMMER COURSE

The Institute of Statistics of the University of North Carolina announces a six weeks summer session of intensive instruction in statistics. Instruction will be by R. A. Fisher of Cambridge University, England, Chester Bliss of the Connecticut Experiment Station, George Snedecor of Iowa State College, and by William Cochran, Jack Wolfowitz, and Miss Gertrude Cox, all of the Institute staff. Mr. Wolfowitz will present a course in sequential analysis which should be of interest to industrial students. Other courses will offer instruction in statistics at both the elementary and advanced levels. These courses will in general require a reasonable knowledge of calculus as a prerequisite, and are not intended to take the place of the familiar intensive courses in quality control, but rather to afford those desiring a deeper knowledge of statistics the opportunity to acquire it. For information, write to the Institute of Statistics, Raleigh, N. C.

A.I.E.E. MEETING

A three day sectional meeting of the American Institute of Electrical Engineering will be held at Hotel Statler, Buffalo, New York, April 24, 25, 26. On Thursday afternoon, April 25, at 3:00 a panel discussion on Quality Control Applications will be held. On the panel will be Martin Brumbaugh, University of Buffalo, Joseph Manuele, Westinghouse Electric Corporation, Alfred Winterhalter, Colonial Radio Corporation, and Douglas Stewart, General Electric Corporation. Everyone interested in quality control is invited to attend this meeting.

DIMENSIONAL QUALITY CONTROL



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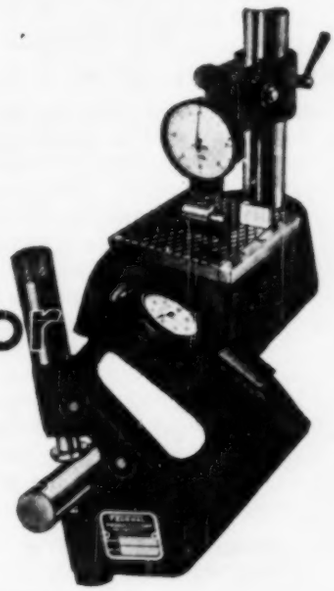

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